Evolution of CT

Computed Tomography (CT) imaging, also known as “CAT scanning” (computed axial tomography) is a name derived from the Greek word tomos meaning “slice” or “section” and graphia meaning “describing.” The CT scan or computerized tomography scan was invented by British electrical engineer Godfrey Hounsfield in the early 1970s at the EMI Laboratories in England. Hounsfield was later awarded the Nobel Prize for his contributions to medicine and science.

CT technology uses X-rays and computers to create a cross-sectional slice of the body. The CT scanner produces slices of the body in much the same way a loaf of bread is sliced. Each image provides detailed anatomy of the body at the specific slice, including bones, soft tissue, brain, organs and blood vessels. The first CT scanner took several hours to acquire raw data for a single scan or “slice” and took days to reconstruct a single image from that data.

The first clinical CT scanners were installed between 1974 and 1976. The first systems were dedicated to head imaging only, with single-slice acquisition taking seven minutes. By 1976, CT grew to image beyond the head with scanner design changing to have larger patient openings and single-slice acquisition.

The introduction of spiral CT scanners in 1991, and subsequently multislice CT detectors in 1998, represented major milestones in the development of CT scanners. These scanners enabled fast examinations of large body regions with high resolution of anatomic detail. As scanners and computers continued to improve, most single-slice CT scanners in the US were replaced with multislice units. The first multislice CT scanners were introduced with 4-slice technology. Rapid technological developments led to 16-slice CT scanners in 2001, and then to 64-slice CT scanners in 2003. Today, more than 70% of all CT scanners installed in the US include multislice CT technology. These volume imaging scanners provide detailed information that can be manipulated by the technologist to produce two- and three-dimensional images of the body.

The first dual source CT (DSCT) system was introduced in 2005 with the Siemens SOMATOM Definition™. This groundbreaking technology provides clear images, the most detailed yet seen in CT. The advantages of earlier diagnosis of disease states combined with unprecedented image quality have revolutionized the field of CT once again.

During its more than 32-year history, CT has made great improvements in speed, image quality, clinical capability, and patient comfort. As CT scan times have become faster, more anatomy can be scanned in less time. CT exams are now quicker and more patient friendly than ever before.
Quick Reference

The following terms are provided as a quick reference to the technical and medical words used to describe computed tomography and the uses of the technology in medical care.

Abbreviations

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Acquisition Speed
Speed (measured in mm/sec) at which a CT scan of a body region is performed.

Acute Care
Short-term medical care, especially for serious acute disease or trauma, e.g., acute-care hospitals; an acute-care nursing unit.

Adaptive ECG-Pulsing
A capability of the Siemens CT to modulate the X-ray exposure in synchronization to the heart cycle in order to reduce radiation dose.

Adaptive 3D Intervention
Guided CT intervention that puts the physician in virtually full control on any plane from the CT scan room, without having to position a technologist at the CT console to guide the procedure. Adaptive 3D technology overcomes the barriers associated with traditional CT 2D fluoroscopy and enters the 3D arena for much faster procedure time and more advanced needle and procedure planning.

Adaptive Scanner
A CT scanner that is designed to adapt to virtually any patient need: pediatric, obese, cardiac, trauma. Responding in seconds, the scanner adapts to the clinical task at hand protecting the patient further by automatically contouring and blocking irrelevant areas from receiving dose – thus, organ-specific dose reduction. Pending 510(k) review

Angiography
Examination of the blood vessels using X-rays after the injection of a radiopaque contrast medium into the vessels, which makes them appear much more clearly and distinctly on the image.

Arrhythmia
An abnormal rhythm of the heartbeat.

Adaptive 4D Spiral
A scan mode that applies a continuous bidirectional shuttle table movement and adapts to virtually any volume coverage desired to provide whole-organ coverage, for example in stroke, tumor or body perfusion. Pending 510(k) review
B

**Beta Blocker**
Pre-medication, injected into or ingested by the patient, used to slow down the heart rate and reduce blood pressure for improving the quality of a cardiac CT exam.

**Bone Subtraction**
Electronic removal of bone tissue from a CT image with limited manual post-processing so that soft tissues and other organs can be clearly seen. This allows physicians to provide immediate feedback to their patients and options for treatment.

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C

**Calcium Scoring**
A CT study that detects and quantifies areas of calcification in the coronary arteries that supply blood to the heart. The display and evaluation of coronary calcifications aid in early evaluation and treatment of heart disease.

**Cardiac Catheterization**
X-ray-based diagnosis and treatment procedure of the heart and the coronary arteries. A tube (catheter) is inserted into the heart via an artery or vein. After contrast agent injection, X-ray images are generated to visualize cardiac anatomy.

**syngo® Cardio BestPhase**
A Siemens software package dedicated for cardiac post-processing to automate finding the optimal cardiac phase for reconstruction. The user simply defines diastole or systole and cardio best phase, locates the phase with least motion and best image quality, and reconstructs.

**Cardio Obese**
A Siemens software package used when scanning large or obese patients. Cardio Obese is protocol driven and allows the user to open the temporal window as a function of post-processing not acquisition. By opening the temporal window, more image information is available to improve image quality.

**CARE Dose4D™**
A Siemens software package designed to automatically customize radiation exposure according to a patient’s specific anatomical characteristics ensuring the best diagnostic image quality at the lowest possible dose. CARE Dose4D modulates dose automatically in the x, y and z planes.
C (continued)

**CAT Scan**
See Computed Tomography (CT).

**CT Clinical Engines**
Siemens offers complete suites of hardware and software diagnostic tools and solutions, from scanning to diagnosis, for oncology, neurology, cardiology and acute care.

**Computed Tomography (CT)**
A diagnostic imaging procedure that uses a combination of X-rays and computer technology to produce cross-sectional images (often called slices) of the body. A CT scan shows detailed anatomical images of any part of the body, including the bones, muscles, fat, and organs. Also referred to as CAT (computed axial tomography).

**Contrast Media**
A solution that is either injected in the vessels (usually iodine based) or ingested (barium), which absorbs a large amount of X-rays when administered. This is necessary to image the vessel and bowel for disease or pathology. (See Angiography.)

**Coronary Vessels**
The great vessels of the heart providing blood flow to the heart – these vessels are the left main, left anterior descending artery, circumflex and right coronary artery.

**CT Angiography**
CT (computed tomography) angiography (CTA) is an examination that uses contrast medium and X-rays to visualize blood flow in arteries throughout the body, from those serving the brain to those bringing blood to the lungs, kidneys, arms and legs.
D

Data Sets
The result of completed examinations from a CT scan. These results can be in cross-sectional (axial) image planes, or in volumetric sets. Data sets are then sent to physicians for review and diagnosis of the study.

Detectors
Measure the X-rays that pass through the patient's body and turn the information into an electronic signal that can be fed into a computer.

Dual Source Computed Tomography (DSCT)
A computed tomography scanner that uses two tubes and two detectors simultaneously in one CT scanner. Dual Source CT is twice as fast as single source (systems with one X-ray tube and one detector), enabling the technologist to reliably perform cardiac imaging independent of the heart rate and without the compromise of beta blockers or multi-segment reconstruction.

E

Early Detection
Viewing disease at an early stage to initiate early and successful treatment.

Effective Dose
A quick calculation of dose measured with the following equation: (mA x rotation speed)/pitch. This gives a rough estimate of dose, but is not as accurate as measurement by DLP (dose length product) or CTDIw (weighted CT dose index).

ECG
Used to aid in CT cardiac scanning, ECGs measure the electrical impulses in the heart by electrodes attached to the body. This information is imperative in scanning cardiac patients and in post-processing to reconstruct at a defined cardiac cycle.

syngo Expert-i
Siemens enables physicians to easily connect remotely within the clinical network to the dedicated syngo® MultiModality, Acquisition Workplace, or CT Workplace, and post-process or review datasets. The user has all the functionality of the workstation remotely.
G

Gantry
The donut-like cylinder part of a CT unit in which a patient is placed for scanning. The housing covers the tube and the detector system that revolves around the patient during scanning.

H

Heart Rate
The primary activity of the heart each time it goes through one complete cycle of pumping blood to and from all parts of the body.

I

Image Acquisition
The process of scanning a patient. As the X-ray is delivered to the patient, the detector below captures the X-ray and acquires the image information. This information is then delivered electronically to a CT processing console to make it ready for physician review.

Image Quality
A measure of the clarity and precision of an X-ray picture. Higher image quality — resulting in clearer anatomy and disease imaging — allows for better diagnosis and treatment.

Innovation
A unique method, idea, practice, or object that is new.

Integrated Workflow
Optimization in the process of handling a patient in a hospital or healthcare facility, from registration, to scanning, to post-processing, and subsequently review and diagnosis of the patient’s data set. From registration to discharge, the patient and the X-ray images and other health records that accompany that patient must flow efficiently through the system and be readily available to all.
Invasive
A type of medical testing that involves penetration into the living body (i.e., an incision or insertion of an instrument) with the potential for complications and risks. An example of an invasive procedure would be catheterization. CT is considered a non-invasive test.

Isotropic Resolution
A measure of 3-dimensional image resolution in which the image voxel has the shape of a cube with equal length, width and height, thus providing excellent image quality in all 3 dimensions. In CT, this is referred to in the x, y and z plane.

SOMATOM Life
A unique customer care solution from Siemens that includes programs which support and enable the continuous development of skills, productivity and technology.

Milligray (mGy)
A unit of measure used for measuring radiation dosage to the patient in CT.

Millisievert (mSv)
Scientific measures used to measure the age and strength of a radiation source. Most often used in the measurement of dose for cardiac examinations, the mSv is the most accurate expression of dose that takes into account patient-specific anatomy.

Modality (in medical imaging)
Modality refers to the type of equipment or probe used to acquire images of the body. Radiography, ultrasound, and computed tomography are examples of modalities.

Motion Artifacts
Distortions in an image as a result of motion during acquisition. They can be diagnostically misleading and may mimic a pathology.
N

Non-invasive
A medical test that does not require entry into the living body and thus will not result in adverse effects to a patient such as medical complications. CT is considered a non-invasive examination.

P

Patient Table
Table that slides the patient into and through the gantry during imaging.

Perfusion
A process of blood flow and distribution in organs and lesions. Perfusion CT imaging can visualize the blood supply of tumors and tissue. It enables the assessment of stroke as well as visualization and differentiation of a tumor with high-resolution CT images.

PET-CT
A system that combines Positron Emission Tomography (PET) and Computed Tomography (CT) to create a single image slice of a portion of the body. Used often to diagnose cancerous lesions and other diseases.

Picture Archiving and Communications System (PACS)
An IT solution used to provide efficient archival, retrieval, communication, and display of digital medical images.

Plaque
Lipid or fibrous deposits found along the inner lining of an artery wall characteristic of atherosclerosis.

Post-Processing
Computerized processing of data sets, after acquisition by the CT system, to create a diagnostic image. The technologist processes most data sets to make them ready for physician review and diagnosis.
R

Radiation Dose
The amount of energy from radiation that is absorbed by the body during scanning. Reduction of the amount of radiation to the body during a CT scan is termed Dose Reduction.

Radiation Exposure
The amount of time and the intensity at which a patient is exposed to radiation.

Rotation Speed
The amount of time it takes the detector and X-ray tube to rotate 360 degrees during a CT acquisition. The faster the rotation speed, the better the CT scanner can freeze patient motion.

S

Scan
The passing of an X-ray beam over the body to produce an anatomical image.

Scan Range
The length or distance the CT scanner is defined to travel based on protocol and patient exam. Maximum scan range is the furthest the table/scanner can travel in a single acquisition and is most often long enough to cover patients head to toe. The Siemens SOMATOM Definition offers a 200-cm scan range.

Scan Speed
Speed at which an image acquisition is performed. This is dependent on a number of factors including: number of slices, rotation speed, patient size and type of exam. Scan speed is defined in the patient protocol and, in advanced MSCT, is often less than 10 seconds (*depending on type of scan).

SOMATOM CT Scanners
The family of Computed Tomography scanners from Siemens. From the first full-body CT in 1977 (SOMATOM 1) through multislice technology to the revolutionary new SOMATOM Definition family in 2007, this group has kept Siemens’ customers ahead of the curve in maintaining state-of-the-art equipment for every conceivable application in CT diagnosis.

SOMATOM Definition Product Family
The newest member of the Siemens CT family. The first of its kind, the SOMATOM Definition uses a dual source computed tomography unit that provides non-invasive imaging in cardiology, neurology, oncology and acute-care settings with unprecedented clarity. The SOMATOM Definition AS and AS+ scanners have joined this family.
S

Spatial Resolution
A measurement of image quality defined by the number of pixels per square inch – the greater the number, the higher the image quality. Spatial resolution is important in organ and tissue imaging, as it allows discernment of small objects from one another in a gray scale where there are not major differences in HU (Hounsfield Units).

Spiral Dual Energy
The use of two X-ray sources at two different kV (kilo voltage) levels simultaneously in one spiral acquisition. The result is a data set offering image information beyond anatomical detail, allowing for characterization of tissue and differentiation of vessel from bone or tissue. How it works – two X-ray sources running simultaneously at different energies.

SPECT·CT
An imaging solution combining Single Photon Emission Computed Tomography and Computed Tomography. It is used for measuring blood flow, metabolism, and imaging at the cellular level, which can track the growth of stem cells.

Stent
A short narrow metal or plastic tube often in the form of a mesh that is surgically inserted into a vessel (e.g., an artery or bile duct), primarily to keep a previously blocked passageway open.

Step and Shoot
A method of cardiac scanning that utilizes a sequence mode (prospective triggering) to gather cardiac information. Step and shoot turns the X-ray on in a pre-defined cardiac phase, then turns the X-ray off and moves to the next slice position – it is NOT a spiral scan and does not produce functional cardiac information. Siemens offers an advanced step-and-shoot package called Adaptive Cardio Sequence.

STRATON™ tube
STRATON X-ray tube is an exclusive CT innovation from Siemens. It features unprecedented cooling rates and is much smaller than conventional X-ray tubes. The compact design of the STRATON tube is a prerequisite for the design of a dual source CT and Siemens revolutionary z-Sharp™ technology.

syngo®
Siemens integrated common software platform that provides a common architecture, intuitive interface, and set of applications that optimizes workflow across Siemens modalities (MR, AX, CT, Nuclear, etc.)
**Temporal Resolution**
Measurement of image quality based on the time it takes to acquire one single cross-sectional image—it can best be described as the rotation speed of the CT scanner. The higher the temporal resolution, the better the CT scanner can freeze motion. Common examples of a need for high temporal resolution are: cardiac scanning, pediatric imaging and brain imaging.

**Thin client**
A new technology which provides advanced post-processing tools remotely versus through a dedicated workstation. All advanced applications and robust computing hardware reside on a server (versus a dedicated workstation computer), which can be seamlessly accessed remotely via an Internet connection*. Siemens thin-client solution is called WebSpace.

**UFC Detector**
Siemens detector material, Ultra-Fast Ceramic detectors. These are able to acquire image information and process it the fastest in the industry, allowing for more than 4,600 samples (projections) per rotation with z-Sharp technology.

**WorkStream4D**
A Siemens software solution that virtually eliminates the need for time-consuming manual reconstruction steps by automating post-processing and driving it through scan protocols. WorkStream4D allows for automated reconstruction of raw data into coronal, sagittal, oblique or double oblique planes.

**syngo WebSpace**
Siemens Server/thin-client technology that brings 3D CT data directly to any office computer, home PC or laptop via an Internet connection.
X-ray
Radiation used for imaging purposes that uses energy beams of very short wavelengths to penetrate the body to help visualize internal anatomic structures. It is the most common of imaging techniques used in healthcare today.

X-ray Tube
A vacuum tube containing an anode, onto which a beam of electrons is directed at high energy for the generation of X-rays.

Z-Sharp™ Technology
Technology that uses two overlapping X-ray beams in the z-direction to enhance image resolution and image quality without an increase in radiation dosage. This technology is unique to Siemens and allows for the industry’s best resolution without an increase in dose.

z-UHR
Siemens proprietary z-UHR (z-Ultra High Resolution) feature enables the industry’s highest resolution of 0.24 mm x 0.24 mm x 0.24 mm. It is intended for ultra-high resolution bone imaging, in particular for wrists, joints, and inner ear studies.
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